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THE USE OF INTERFERENCE CURRENTS IN THE COMBINED EXCLUSION
OF PAIN IN SURGICAL OPERATIONS

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THE USE OF INTERFERENCE CURRENTS IN THE COMBINED EXCLUSION
OF PAIN IN SURGICAL OPERATIONS

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Electronarcosis, first applied in 1902 by Leduc, has recently received new attention because of its indubitable advantages (almost immediate conduction of the patient into the state of painlessness and release from it, broad therapeutic spectrum and absence of side- and aftereffects on the organism).

In the period following Leduc's reports, experimental investigations of electronarcosis were made and individual attempts were made to use electronarcosis in surgery (Robinovitch, Neergard, G.S. Kalendarov, W.A. Glazov, Bonino, Ballestrazzi, N.M. Liwenzev, M.G. Ananyev, Smith). All authors used a current of rectangular shape (of 8 mA on the average and an opening of 1:10), in combination with a galvanic arrangement (average 16 mA) or a sinusoidal current (220 mA effective at an average frequency of 700 cps).

Kirschbaum successfully used electronarcosis in surgical procedures in eight patients with 20-60 percent of the entire body surface. The current

*Numbers given in the margin indicate the pagination in the original foreign text.

reached 108-200 mA during the first minute of narcosis, and was then decreased to 100-110 mA. After the end of the operation the strength of the current was reduced to 0 during the course of 15 min. All eight patients lost consciousness during the operation, but rapidly regained it after the current was turned off. The authors consider electronarcosis the method of choice for operations of burns with definite symptoms of toxemia. 12

Simultaneously with analgesia, at the beginning of pain elimination the electric current produced general muscle stiffness, labored breathing because of laryngeal cramps, considerable increase in blood pressure, tachycardia and definitely disagreeable sensations while the electrodes were attached.

In earlier days electronarcosis could not compete with other narcotics, because the preference was for extensive deep narcosis and muscle relaxation. But in later years considerable changes developed in general anesthesia, and it grew to be quite complicated. Some narcotics serve to deaden the sensation of pain, others to relax muscles, and still others to regulate hemodynamics.

In this new stage of development of general anesthesia, attempts have been made to support electronarcosis and to add, for general anesthesia, muscle relaxants and ganglionic blocking agents (Lombard, Knutson).

Hardy was the first to conduct operations in 12 cases under electronarcosis lasting as long as 2-1/2 hours. Like others, this author used a sinusoidal current of a frequency of 700 cps. The strength of the current varied between 45 and 110 mA. Premedication consisted of secobarbital (75-100 mg) and atropine (0.8 mg). Intubation was done after administration of thyamyl (200 mg) and succinyl choline (50 g). The current was then increased to the strength necessary to obtain anesthesia. After operation the tube was

removed and the current was shut off. The narcotizing action of the current immediately disappeared.

However, even with this method a clearly expressed tachycardia (up to 140 per min) and arterial hypertension (to 260 mm) were observed. The patients themselves considered the sensation of the current disagreeable. In two of the twelve patients the elimination of pain was incomplete, probably because of the lack of choice of current strength. In one patient complications occurred, namely, first degree burns with the electrodes. There were no changes referable to electronarcosis in the electrocardiograms and electroencephalograms made before and during narcosis. Biochemical investigations were made in 5 patients; these showed increase of catecholamines and 17-hydroxycorticosteroids in the blood as well as an increase of oxygen exponents in the blood during the operation.

It must be concluded, therefore, that electronarcosis, with sinusoidal currents and even in combination with the usual anesthetic additives, does not fulfill the requirements demanded of general anesthesia.

Recently new modifications of the type of current have been proposed, by means of which the adverse side reactions could be avoided, while retaining the narcotic action and effect on the central nervous system. One of these modifications is the interference current. The phenomenon of interference of two currents of similar frequency, hardly sensed by the nerve endings (skin, ^{current} subcutaneous tissue) induces frequent fluctuation which is indispensable for electronarcosis. The degree of amplitude of the proper resulting fluctuation is considerably greater than the chrome amplitude of the interfering frequencies. We therefore obtain above-threshold effects in the deeper organs with below-threshold current strengths; the structures of the brain stem is one of these organs.

On the recommendation of N. M. Liwenzev we conducted an experiment to clarify the use of interference currents for elimination of pain in surgical operations. During the course of this experiment we developed a special apparatus - GIT-2 - (generator for interference currents), which produced interference currents sufficient for anesthesia.

Before using the apparatus clinically, we conducted twenty combined electro-anesthesias in dogs; premedication consisted of 25-50 mg copenthal-sodium and 0.2 mg lystanon per kg body weight for muscle relaxation, with control of respiration. Respiration, pulse rate, arterial and venous pressures and the rectal temperatures were noted, and electrocardiograms were taken before and after the experiments.

The results were such that clinical application seemed justified. Proper choice of the narcotizing current strength is most important for successful [] combined electronarcosis. This criterion has not been pointed out in the literature. In order to clarify this problem, we determined, on the eve of operation, that particular minimal current strength which would just barely induce superficial analgesia, without other side effects which would disturb the patient. Such a test probe was done in 30 patients. The threshold of this superficial anesthesia varied in these patients from 2.5 - 12 mA and generally was higher in males than in females. This value was particularly high in males used to considerable quantities of alcohol.

We used interference current for electronarcosis in 26 patients with the following surgical conditions: mastectomy, diagnostic laparotomy with resection of the abdominal cavity, resection of the small intestine, reduction of fractures, appendectomies, and removal of varicose veins.

Premedication consisted of 0.5 atropin and 20 mg promedol 30 min before the operation. In seven patients with particularly labile nervous systems we added 25 mg aminasin. Following induction of anesthesia with 250-300 mg hexenal and using 80-100 mg lystanon for muscle relaxation, intubation was done; respiration was carefully observed and controlled for the entire duration of the operation. The current strength was increased by one-half of the previously determined value (30-50 mA). At the beginning of the operation we increased the strength to 60-100 mA. The electrodes were placed on the temples and the nape of the neck.

During the anesthesia and the operation the arterial pressure rose, as it always does with any anesthesia (caused by intubation) in its initial phase; it then fell to its initial value, but then increased by 8 mm. The pulse frequency increased by 16 beats per minute with the increase in arterial pressure; however, it then decreased and remained stable to the end of the operation. Like the arterial pressure the venous pressure also increased at the beginning of the anesthesia by 22 mm WS and then returned to normal.

In 24 of 26 patients elimination of pain was complete, the patients gave no reactions even during the most severe traumatic moments of the operation. In two patients elimination of pain was not complete at the beginning of operation because of incorrect current strength. Furthermore, the RR increased by 35-40 mm at the beginning of the operation and showed no decrease by the end of the operation. Pulse frequency increased periodically up to 120-140 beats per minute, and several times during the operation there was dilation of the pupils.

Hardy and Turner reported that during operations under combined electro-anesthesia with sinusodial currents thyamil was required periodically,

in addition to muscle relaxants, to effect decrease of tachycardia and blood pressure. However, the use of interference currents eliminates the need for these additives, because with the proper choice of current strength the pulse frequency and RR remain stable on a plateau similar to the one present at the beginning.

We could chat with the patients immediately after the tube was removed. The patient does not consciously feel the effect of the current during the operation. There is no feeling of pressure at the points of contact with the electrodes, such as is felt in the case of sinusoidal and impulse currents. Eleven patients retained a slight sensation of touch in these areas, they were able to describe these areas during the operation. (Editor: apparently these patients were not completely anesthetized, undoubtedly a fault of the routine.) The other patients could not remember anything, indicating that the current dose had reached the threshold of unconsciousness. We have to conclude, therefore, that the elimination of pain was two to three times stronger than observed in the first stage during the test probes. The amount of muscle relaxant, administered during the course of the operation, was no more than the usual quantity.

In the postoperative period two patients complained of muscle pains, a phenomenon which has also been observed with the use of muscle relaxants in combination with other methods of inducing anesthesia. One patient complained of headache for 48 hours after operation. No other complications were observed.

Conclusions

1. Interference currents have a definite place in modern methods of pain elimination.

2. Combined electronarcosis using interference currents has a striking advantage over earlier methods of electronarcosis.

3. The method of combined electronarcosis with interference currents is simple and safe, and it is definitely recommended for surgical practice.

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